

## WEST Search History





DATE: Friday, March 19, 2004

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	<i>DB=USPT; PLUR=YES; OP=ADJ</i>		
<input type="checkbox"/>	L31	((after with cmp) or (post cmp)) and brush and copper and indexer	10
<input type="checkbox"/>	L30	((after with cmp) or (post cmp)) and brush and copper and box and indexer	0
<input type="checkbox"/>	L29	L28 and (ph with ('3.0' or '4.0'))	4
<input type="checkbox"/>	L28	L27 and acid	50
<input type="checkbox"/>	L27	L26 and ph	60
<input type="checkbox"/>	L26	L25 and brush	132
<input type="checkbox"/>	L25	post cmp	347
<input type="checkbox"/>	L24	L23 and ph	3
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<input type="checkbox"/>	L22	ontrak.as.	34
<input type="checkbox"/>	L21	L20 and copper	30
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	<i>DB=JPAB; PLUR=YES; OP=ADJ</i>		
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<input type="checkbox"/>	L7	L6 and copper and cmp	21
<input type="checkbox"/>	L6	photovoltaic	8986
<input type="checkbox"/>	L5	L2 and copper	15
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END OF SEARCH HISTORY

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**End of Result Set**



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L16: Entry 1 of 1

File: USPT

Oct 1, 2002

DOCUMENT-IDENTIFIER: US 6458674 B1

TITLE: Process for manufacturing semiconductor integrated circuit device

Brief Summary Text (14):

FIG. 14(a) is a model diagram illustrating an electromotive force generating mechanism of the pn junction; FIG. 14(b) is a graph illustrating the I-V characteristics of the pn junction at a light irradiation time and at a dark time; and FIG. 15 is a model diagram illustrating a corrosion occurring mechanism of the Cu wirings.

Brief Summary Text (15):

When light comes into the pn junction formed in the silicon substrate, as shown in FIG. 14(a), an external voltage (up to 0.6 V) at + on the p-side and at - on the n-side is generated by the photovoltaic effect of silicon, so that the I-V characteristics of the pn junction are shifted, as illustrated in FIG. 14(b). As a result, a short-circuit current flows, as illustrated in FIG. 15, through a closed circuit which is formed of a Cu wiring connected with the p-side (or + side) of the pn junction--the pn junction--the Cu wiring connected with the n-side (or - side) of the pn junction--the polishing slurry which has stuck to the wafer surface, so that the Cu.sup.2+ ions are dissociated from the surface of the Cu wiring connected with the p-side (or + side) of the pn junction, thereby to cause electrochemical corrosion (or electrolytic corrosion).

Brief Summary Text (16):

FIG. 16 is a graph showing relations, which occur at a time a voltage is applied, between a slurry concentration (%) and a Cu etching (eluting) rate. For a slurry concentration of 100%, as seen from FIG. 16, the eluting rate of Cu is relatively low, but abruptly rises when the polishing slurry is diluted to some extent with water. It can be said from the foregoing discussion that, when light comes in a pn junction in a case where some of the polishing slurry or its aqueous solution has stuck to the surface of the silicon wafer, the elution of Cu grows prominent to cause electrolytic corrosion. Concretely, when light comes in the surface of the wafer either in the course of conveyance from the polishing step to the post-cleaning step or at a standby time, electrolytic corrosion occurs in the Cu wirings connected with the p-type diffusion layer of the pn junction.

Drawing Description Text (16):

FIG. 14(b) is a graph illustrating I-V characteristics of the pn junction at a light irradiation time and at a dark time;

Detailed Description Text (13):

The term "shading" generally refers to an illuminance within such a range that the electrochemical corrosion is not intensified by light, and widely refers to a substantial darkening to an illuminance of 1,000 luxes or less in the working region of an ordinary wafer step. That is, it goes without saying that this shading includes not only a shading of light from the environment with a shading wall or the like, but also a darkening of the illumination of the place itself where the apparatus is placed. When an essential portion is to be exclusively shaded with a shading wall or a shading film, an advantage is attained in that the object can be achieved without lowering the workability in the remaining portions. In this connection, the invention can generally expect a considerable effect for an illuminance of 500 luxes or less. Considering the heterogeneity of the flow of the wafer to be treated in the mass production, however, an illuminance of 300 luxes or less is desired in the wetting treatment relating to the CMP, i.e., after the CMP treatment portion to the drying step of the post-cleaning step. Of these, further, an illuminance of 200 luxes or less is more desirable especially in corrosible portions (for the CMP, corrosion-preventing, pre-cleaning, wetting and post-cleaning treatments). Moreover, in such a region in these CMP related wetting portions which require no considerable illuminance for the processing, a stable corrosion-preventing effect can be ensured by setting the illuminance to 150 luxes or less, more desirably to 100 luxes or less.

Detailed Description Text (14):

Further, when there is used an abrasive grain-free CMP (or widely a CMP using a slurry containing 0.5 wt. % or less of abrasive grains, as the abrasive grain concentration in the slurry is ordinarily 0.1 wt. % or less. When more stable characteristics are demanded, however, the concentration is desired to be 0.05 wt. % or less.), since the polishing treatment is conducted mainly in the metal corrosion region, it is considered that the necessity for the shading is enhanced in order to suppress the electrochemical corrosion by light.

Detailed Description Text (43):

Further, this CMP apparatus 100 is able to prevent a short-circuit current from being generated by a photovoltaic effect, by providing a shading structure for the immersing portion (or wafer stocking portion) 150 for preventing the surface of the anticorroded wafer 1 from becoming dry, thereby to prevent the surface of the stocked wafer 1 from being illuminated with an illuminating light. In order to provide the immersing portion 150 with a shading structure, the illuminance of the inside of the immersing bath (or stocker) is set to at most 500 luxes or less, preferably 300 luxes or less, more preferably 100 luxes or less, by coating the surrounding portion of the immersing bath (or stocker) with a shading sheet.

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L31: Entry 9 of 10

File: USPT

Dec 19, 2000

DOCUMENT-IDENTIFIER: US 6162301 A

TITLE: Methods and apparatus for cleaning semiconductor substrates after polishing of copper film

Abstract Text (1):

A cleaning solution, method, and apparatus for cleaning semiconductor substrates after chemical mechanical polishing of copper films is described. The present invention includes a cleaning solution which combines deionized water, an organic compound, and a fluoride compound in an acidic pH environment for cleaning the surface of a semiconductor substrate after polishing a copper layer. Such methods of cleaning semiconductor substrates after copper CMP alleviate the problems associated with brush loading and surface and subsurface contamination.

Brief Summary Text (3):

This invention relates to methods and apparatus for processing and cleaning a substrate, and more specifically to methods and apparatus for cleaning semiconductor substrates after polishing of copper films.

Brief Summary Text (5):

In the manufacture of advanced semiconductor devices, copper (Cu) is beginning to replace aluminum (Al) as the material for metallization. Cu has become desirable due to its lower resistivity and significantly improved electromigration lifetime, when compared to Al.

Brief Summary Text (6):

One process for Cu metallization uses a dual damascene approach. As illustrated in FIG. 1a, a dielectric layer 110 is deposited above a substrate 100. Dielectric layer 120 may be made up of materials such as silicon dioxide. Vias and/or trenches 120 are then formed in the dielectric layer 110, as illustrated in FIG. 1b. Vias/trenches 120 may be formed, for example, using dry etching techniques. Next, a thin layer of barrier material (barrier layer) 130, for example, tantalum (Ta), titanium (Ti), or titanium nitride (TiN) is deposited as illustrated in FIG. 1c. After barrier layer 130 is deposited the vias/trenches copper 110 are filled with copper (Cu) layer 140, as illustrated in FIG. 1d. Such as copper layer 140 may be deposited using well known deposition techniques, for example, chemical vapor deposition (CVD), physical vapor deposition (PVD), or electroplating. In order to isolate the copper interconnects, as illustrated in FIG. 1e, the excess copper layer 140 and barrier layer 130 must be removed.

Brief Summary Text (7):

One method for removing the excess copper layer 140 and barrier layer 130 is

h   e b   b g e e e f   c   e   g g

polishing the surface of the substrate, for example, polishing using chemical mechanical polishing (CMP). In a CMP process, the semiconductor substrate is polished with a slurry containing abrasive particles, such as alumina particles, and an oxidant, such as hydrogen peroxide. In the CMP process, contaminants are introduced which include particles and/or metal contamination on the copper surface 150, dielectric surface 160, and in the dielectric subsurface 165.

Brief Summary Text (8):

Regardless of how the CMP process is performed, the surface of semiconductor substrate must be cleaned of contaminants. If not removed, these contaminants may affect device performance characteristics and may cause device failure to occur at faster rates than usual. Cleaning the semiconductor substrate after chemical mechanical polishing of copper may be necessary to remove such contaminants from the copper layer and dielectric layers.

Brief Summary Text (9):

One method for cleaning the semiconductor substrate after polishing of the copper layer is brush scrubbing. Brush scrubbing, whether single-sided or double-sided brush scrubbing, is the industry standard for cleaning oxide and tungsten CMP applications. However, there are several problems associated with applying brush scrubbing to post copper CMP cleaning.

Brief Summary Text (10):

One such problem is brush loading. During the CMP process, the top surface of the copper layer may be oxidized and forms copper oxide, for example copper oxide ( $\text{Cu.sub.2 O}$  or  $\text{CuO}$ ) or copper hydroxide ( $\text{Cu(OH).sub.2}$ ). In basic or neutral pH cleaning environments, the copper oxide or copper hydroxide does not dissolve and may be transferred to the brushes, thus loading the brushes. The contaminated (or loaded) brushes may then transfer the copper oxide or copper hydroxide contaminants to subsequently processed substrates during cleaning.

Brief Summary Text (11):

For tungsten and other oxide applications, brush loading could be curtailed by adding a dilute ammonium hydroxide ( $\text{NH.sub.4 OH}$ ). In the presence of  $\text{NH.sub.4 OH}$ , part of the copper oxide may form  $\text{Cu(NH.sub.3).sup.2+}$  complex and may be dissolved; however, due to the high pH environment, the dilute ammonium hydroxide has been found to be insufficient to prevent brush loading of copper oxide. Additionally, it has been found that scrubbing with dilute ammonium hydroxide also causes etching of the copper layer and may cause serious surface roughening.

Brief Summary Text (12):

Brush loading may also occur when alumina particles are used in the copper CMP process. In neutral or inorganic acid (e.g.  $\text{HCl}$ ) cleaning environments, there is an electrostatic attraction between alumina particles and the silicon dioxide surface which makes it difficult to remove the alumina particles from the surface of the dielectric material. Because of the electrostatic attractive force, the alumina particles may also adhere to the brush and cause another brush loading problem with similar effects to those discussed above.

Brief Summary Text (13):

Yet another problem caused by the CMP process is that the surface and subsurface of the dielectric layer may become contaminated during polishing with metal from the copper layer and barrier layer as well as other contaminants from the slurry. During the CMP process, contaminants, especially metal contaminants, may penetrate into the dielectric layer up to approximately 100 angstroms (.ANG.) from the surface. Again, these contaminants may affect device performance characteristics and may cause device failure.

Brief Summary Text (14):

Thus, what is needed is a cleaning environment and methods for cleaning post copper CMP substrates that alleviate the problems of brush loading without affecting the quality of the copper and dielectric layers. Furthermore, what is needed is a cleaning environment and methods for cleaning post copper CMP substrates that have the capability of removing surface and subsurface contaminants from the copper and dielectric layers.

Brief Summary Text (16):

A cleaning solution, methods and apparatus for cleaning semiconductor substrates after chemical mechanical polishing of copper films is described. The present invention includes a cleaning solution which combines deionized water, an organic compound, and a fluoride compound in an acidic pH environment for cleaning the surface of a semiconductor substrate after polishing a copper layer.

Drawing Description Text (6):

FIG. 1d illustrates the semiconductor substrate of FIG. 1c after a layer of Copper material has been deposited thereon.

Drawing Description Text (7):

FIG. 1e illustrates the semiconductor substrate of FIG. 1d after chemical mechanical polishing of the excess copper layer and barrier layer.

Detailed Description Text (2):

Methods and Apparatus for Cleaning Semiconductor Substrates After Polishing of Copper Film are disclosed. In the following description, numerous specific details are set forth such as specific materials, processes, parameters, dimensions, etc. in order to provide a thorough understanding of the present invention. It will be obvious, however, to one skilled in the art that these specific details need not be employed to practice the present invention. In other instances, well known materials or methods have not been described in detail in order to avoid unnecessarily obscuring the present invention.

Detailed Description Text (3):

The following description describes a cleaning solution, methods, and apparatus for cleaning a semiconductor substrate after the formation of copper interconnect(s) and chemical mechanical polishing (CMP)/planarization of that copper interconnect(s). It should be noted that the processes for formation of copper interconnects in semiconductor device fabrication are well known in the art and are therefore not described in detail herein.

Detailed Description Text (6):

As described in the background of the invention after the copper interconnects on a semiconductor substrate have been planarized using CMP

techniques, it is necessary to clean the semiconductor substrate and remove any contaminants from the surface and subsurface of the semiconductor substrate. One such technique for removing contaminants from the semiconductor substrate is scrubbing the semiconductor substrate (substrate).

Detailed Description Text (8):

FIG. 2 represents a cross sectional view of a Synergy configuration (cleaning system). Usually, the contaminated substrates are delivered to the cleaning system after chemical mechanical planarization (CMP), from a wet bench, or from other processes resulting in contamination. At the start of the cleaning process contaminated substrates are loaded into a wafer cassette 280 (cassette) and the cassette 280 is then placed into the wet send indexer station 210. After cassette 280 is placed into wet send indexer station 210, the substrates are automatically removed from the cassette 280 and placed, one at a time, into the outside brush station 220.

Detailed Description Text (9):

In the outside brush station 220, a substrate is processed through a first scrub. During the first scrub, the cleaning solution may be applied to the substrate in several different ways. For example, in one embodiment the cleaning solution is sprayed onto the substrate. In another embodiment the cleaning solution is applied to the substrate through brushes 221. Yet another embodiment applies the cleaning solution by dripping the cleaning solution onto the substrate.

Detailed Description Text (10):

The scrubbed substrate is then automatically removed from the outside brush station 220 and placed into the inside brush station 230. In the inside brush station 230, the substrate is processed through a second scrub. In the inside brush station 230 the cleaning solution may be applied to the substrate in a similar manner as in outside brush station 220.

Detailed Description Text (11):

After the second scrub the substrate is then automatically removed from the inside brush station 230 and placed into the rinse, spin and dry station 240. Rinse, spin, and dry station 240 rinses, spins, and dries the substrate. At this point the wafer has been cleaned.

Detailed Description Text (13):

It will be clear to one of ordinary skill in the art that some of the steps in the cleaning system described above may occur in another order and/or with various solutions depending upon the substrate or substrate layer being cleaned. For example, different cleaning solutions, such as water, citric acid, ammonium hydroxide, ammonium citrate, and hydrofluoric acid solution (or mixtures of solutions) may be used in one of the brush stations. Also, other systems may include one brush station, or more than two brush stations. Moreover, other systems may omit one or more of the above stations/steps and may include additional processing stations, such as a CMP station.

Detailed Description Text (15):

FIG. 3 illustrates one embodiment of the process of the present invention. At step 310, the copper layer is planarized using chemical mechanical polishing. It should be noted that other techniques for planarization of the copper



layer may be used and that it may still be desirable to clean the semiconductor substrate using the present invention after such planarization in order to remove potential contaminants from the substrate surface and/or subsurface.

Detailed Description Text (16):

At step 320, the polished semiconductor substrate is then placed in a scrubber. The substrate is then scrubbed, at step 330, to remove the contaminants caused by the polishing process. During scrubbing, a cleaning solution is applied to the substrate in order to aid and/or effectuate the removal of the contaminants (step 340). This cleaning solution may be used in either outside brush station 220 or inside brush station 230, or both brush stations if necessary, of the scrubber in FIG. 2.

Detailed Description Text (17):

In one embodiment, the present invention uses a cleaning solution that is made up of deionized water, an organic compound, and a fluoride compound, all of which are combined in an acidic pH environment for cleaning the surface of a semiconductor substrate after polishing a copper layer. The use of an acidic pH environment helps dissolve copper oxide and alleviates some of the problems of brush loading discussed in the background of the invention. It should be noted that it is desirable to keep the acidic pH environment within a pH level range of approximately 1-6. In one embodiment of the present invention, the acidic pH environment has a pH level in the range of approximately 2-4.

Detailed Description Text (18):

The use of an organic compound helps to change the electrostatic forces between the particles and surfaces of the brush and substrate in order to make them repulsive. Thus, the particles repel the brushes and the substrate and the substrate and brushes repel the particles providing favorable conditions for particle removal. The organic compound used may be an organic acid, the ammonium salt of an organic acid, or an anionic surfactant. Some examples of potential organic acids may be: citric acid, malic acid, malonic acid, succinic acid, or any combination of such organic acids.

Detailed Description Text (20):

The use of a fluoride compound helps to remove the contaminants from the surface and subsurface of the dielectric layer. The present invention incorporates the use of fluoride compounds such as hydrogen fluoride acid (HF) or ammonium fluoride (NH<sub>4</sub>F) in the cleaning solution. HF or buffered HF (ammonium fluoride mixed with HF) etches silicon dioxide. Thus, during the scrubbing process the silicon dioxide layer is also etched. For example during the brush scrubbing process, typically between 10-100 .ANG. of the oxide layer is removed, leaving clean, uncontaminated dielectric surface on the substrate.

Detailed Description Text (22):

The cleaning solution of the present invention is a mixture of chemicals in DIW containing a fluoride compound such as HF or NH<sub>4</sub>F; an organic acid, an ammonium salt of an organic acid, or an anionic surfactant; in an acidic pH environment. It should be noted, however, that hydrochloric acid (HCl) may also be added to the solution to adjust pH and help dissolve copper oxide. It should also be noted that the chemicals of the present invention are pre-

mixed in the same cleaning solution to simultaneously solve several problems related to post copper CMP cleaning using a brush scrubber. Cross contamination from substrate to substrate and within the same substrate are therefore reduced substantially, or even prevented in this simple approach.

Detailed Description Text (24):

Thus, methods and apparatus for cleaning semiconductor substrates after polishing of copper film have been described. Although specific embodiments, including specific equipment, parameters, methods, and materials have been described, various modifications to the disclosed embodiments will be apparent to one of ordinary skill in the art upon reading this disclosure. Therefore, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention and that this invention is not limited to the specific embodiments shown and described.

CLAIMS:

1. A method to remove contaminants from a semiconductor substrate, comprising:

placing the semiconductor substrate having a polished copper layer in a scrubbing apparatus; and

scrubbing the semiconductor substrate in an acidic cleaning solution formed by mixing about 100 ppm to about 2% by weight of an organic acid selected from the group consisting of citric acid, malic acid, malonic acid, succinic acid, and mixtures thereof and about 0.1% by weight to about 5% by weight of a fluoride compound selected from the group consisting of hydrogen fluoride, ammonium fluoride, and buffered hydrogen fluoride (ammonium fluoride mixed with hydrogen fluoride) in deionized water, the acidic cleaning solution having a pH in a range from about 2 to about 4.

7. A scrubber for processing a semiconductor substrate, comprising:

an input to receive a semiconductor substrate having a polished copper layer;

a brush assembly coupled to the input; and

a cleaning solution delivery system for delivering a cleaning solution formed by mixing about 100 ppm to about 2% by weight of an organic acid selected from the group consisting of citric acid, malic acid, malonic acid, succinic acid and mixtures thereof and about 0.1% by weight to about 5% by weight of a fluoride compound selected from the group consisting of hydrogen fluoride, ammonium fluoride, and buffered hydrogen fluoride (ammonium fluoride mixed with hydrogen fluoride) in deionized water, the cleaning solution having a pH in a range from about 2 to about 4, wherein the cleaning solution delivery system delivers the cleaning solution premixed in an acidic pH environment to the semiconductor substrate having the polished copper layer.

12. A method to remove contaminants from a semiconductor substrate, comprising:

placing the semiconductor substrate having a polished copper layer in a

scrubbing apparatus; and

scrubbing the semiconductor substrate in a cleaning solution formed by mixing about 0.1% by weight of citric acid and about 0.2% by weight to about 1% by weight of buffered hydrogen fluoride (ammonium fluoride mixed with hydrogen fluoride) in deionized water, the cleaning solution having a pH of about 4.

14. A scrubber for processing a semiconductor substrate, comprising:

an input to receive a semiconductor substrate having a polished copper layer;

a brush assembly coupled to the input; and

a cleaning solution delivery system for delivering a cleaning solution formed by mixing about 0.1% by weight of citric acid and about 0.2% by weight to about 1% by weight of buffered hydrogen fluoride (ammonium fluoride mixed with hydrogen fluoride) in deionized water, the cleaning solution having a pH of about 4, wherein the cleaning solution delivery system delivers the cleaning solution premixed in an acidic pH environment to the semiconductor substrate having the polished copper layer.

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L29: Entry 4 of 4

File: USPT

Nov 14, 2000

DOCUMENT-IDENTIFIER: US 6147002 A

TITLE: Process for removing contaminant from a surface and composition useful therefor

Abstract Text (1):

Particulate and metal ion contamination is removed from a surface, such as a semiconductor wafer containing copper damascene or dual damascene features, employing aqueous composition comprising a fluoride containing compound; a dicarboxylic acid and/or salt thereof; and a hydroxycarboxylic acid and/or salt thereof.

Brief Summary Text (6):

Polishing slurries used for this planarization are typically aqueous suspensions comprised of a metal oxide abrasive (such as alumina), organic acids, surfactants, and a suitable oxidizing agent. This process is known as chemical-mechanical polishing (CMP). The oxidizing agent works to enhance mechanical removal of material via a corrosion assisted process. Such oxidizing agents employed in commercially-available or proprietary slurries are typically inorganic metal salts such as FeNO.sub.3, or KIO.sub.3, and also hydrogen peroxide, present in significant concentrations. Other chemicals added to slurries to improve dispersion or otherwise enhance performance often are organic acids (e.g. citric acid). Sodium, potassium, and iron salts and/or compounds are frequently used in slurry formulations, and significant amounts of these metal ion impurities can remain on the wafer after polishing and post-polish cleaning.

Brief Summary Text (15):

In particular, the present invention relates to an aqueous composition comprising about 0.5% to about 5% by weight of a fluoride containing material, about 0.05% to about 1% by weight of at least one dicarboxylic acid, salt thereof or mixture thereof; about 0.5% to about 5% by weight of a hydroxycarboxylic acid, salt thereof or mixture thereof and the remainder being substantially water, and having a pH of about 3.0 to about 5.7.

Brief Summary Text (16):

A further aspect of the present invention is concerned with a process for removing particulate contaminants from a copper surface after CMP planarization. In particular, the process comprises contacting a copper surface that has been planarized by CMP with an aqueous composition comprising a fluoride containing material; at least one dicarboxylic acid, salt thereof or mixtures thereof; and at least one hydroxycarboxylic acid, salt thereof, or mixture thereof, and having a pH of about 3.0 to about 5.7.

Brief Summary Text (17):

A still further aspect of the present invention relates to a process for fabricating semiconductor integrated circuits. The process comprises forming circuits on the surface of a semiconductor wafer by photolithographic process wherein the circuits comprise copper or copper alloy; planarizing the surface by chemical mechanical polishing; and removing particulate and metallic (e.g.--metal ion) contaminants from the surface by contacting with an aqueous composition comprising fluoride containing material; at least one dicarboxylic acid, salt thereof or mixture thereof; and at least one hydroxy carboxylic acid, salt thereof or mixture thereof and having a pH of about 3.0 to about 5.7.

Brief Summary Text (22):

The copper interconnects typically use either tantalum, tantaium nitride, or titanium or titanium nitride as a barrier or liner material between the copper and the dielectric. As such, the post-CMP cleaning solution is meant to clean up to four or more different materials, copper, the liner material, the dielectric or capping layer, as well as the wafer backside, which is generally a thin layer of oxidized silicon. All these types of materials are exposed on the surface of the semiconductor device during post-CMP cleaning. Accordingly, the cleaning composition must not adversely effect any of these materials to an undesired degree while still effectively removing the contaminants. This places considerable constraints upon developing a suitable composition.

Brief Summary Text (24):

The structure is then contacted with the aqueous composition according to the present invention. The composition comprises a fluoride containing material; at least one dicarboxylic acid and/or salt thereof; and at least one hydroxycarboxylic acid and/or salt thereof.

Brief Summary Text (25):

Typical compounds providing a fluoride ion source according to the present invention are ammonium fluoride or hydrofluoric acid. Other compounds which may provide a source of fluoride ion include, for example, metal salts such as antimony (III/VI) fluoride, barium fluoride, tin (II) fluoride, aluminum (III) fluoride, and fluoroborate compounds. Still other sources of fluoride such as tetramethylammonium fluoride, as well as other organic compounds which could disassociate a fluoride ion in an aqueous media can be used. These other sources include fluoride salts of aliphatic primary, secondary, and tertiary amines. Such have the following formula:

Brief Summary Text (28):

Typical dicarboxylic acids include those having two to six carbon atoms, and include oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, maleic acid and fumaric acid. The preferred acid is malonic acid. Suitable salts include the alkali metal, alkaline earth metal and ammonium salts.

Brief Summary Text (29):

Examples of hydroxycarboxylic acids includes malic acid, tartaric acid and citric acid.

Brief Summary Text (30):

The preferred hydroxycarboxylic acid is citric acid. Suitable salts include alkali metal, alkaline earth metal and ammonium salts.

Brief Summary Text (34):

The dicarboxylic acid and/or salt is typically present in amounts of about 0.05 to about 1 weight %, and preferably about 0.05 to about 0.2 weight %.

Brief Summary Text (35):

The hydroxycarboxylic acid is typically present in the composition at amounts of about 0.5% to about 5% by weight and preferably about 0.5 to about 2% by weight.

Brief Summary Text (37):

In addition, the compositions of the present invention have a pH of about 3.0 to about 5.7 and preferably about 3.5 to about 5.4, a particular example being about 4.0. The pH is typically measured using pH paper or suitable pH reference electrode. It has been discovered according to the present invention that the pH is important in achieving objectives of the present invention. In particular, the compositions are capable of removing metallic and non-metallic particulate oxides, as well as silicon dioxide; metal ion contaminants such as K, Ca, Ti, Cr, Mn, Fe, Ni, Cu and Zn; various sulfur and chloride impurities adsorbed on the various surface materials present on the wafer. CuO is thermodynamically unstable within the pH range of the compositions of the present invention. The removal is achieved while only slightly etching the metallic copper such as less than 5 angstrom/minute and etching dielectric such as high density plasma deposited silicon oxides or TEOS at less than about 20 .ANG./min.

Brief Summary Text (40):

A further feature of the present invention is that the composition even in concentrated form is relatively stable. For instance, concentrates of the composition comprising about 1 to about 20% by weight of the fluoride containing compound, about 1 to about 30% by weight of the hydroxycarboxylic acid, about 1 to about 10% by weight of the dihydroxy carboxylic acid and about 30 to about 50% by weight of water can be provided and transported to the end user, the user can then dilute it such as about a 19:1 dilution by weight at the process tool for convenience and for economical reasons.

Brief Summary Text (41):

The composition can be used in a double sided brush scrubber to clean whole wafers following a copper CMP polishing step. Moreover, such can be used in a megasonic bath or spray tool cleaning apparatus, or combination thereof.

Detailed Description Text (2):

A concentrate comprising about 960 grams of citric acid, about 80 grams of malonic acid, about 1,600 grams of 40% aqueous solution of ammonium fluoride, and about 1,360 grams of deionized water is prepared. The concentrate is then diluted 19:1 (by weight) with deionized water to formulate an aqueous cleaning mixture containing about 1.2 weight % of citric acid, about 0.1 weight % of malonic acid, about 2 weight % of 40% ammonium fluoride and about 96.7 weight % of water. The composition has pH of about 4.0 as measured using a calibrated antimony reference electrode or pH paper.

Detailed Description Text (8):

The wafers are then dipped in Cabot 4110 alumina based slurry for 1 minute and buffed in DI water for 15 seconds. Immediately after the dip and buff step, the wafers are transferred to the Ontrak Synergy double sided brush scrubber cleaning tool. The wafers are cleaned using a flow rate of 500 ml/minute of a cleaning solution prepared according to Example 1 with a brush scrub cleaning time of 45 seconds in the first box, and 10 seconds in the second box. Finally, a 30 second DI spin rinse and blow dry to finish the clean.

Detailed Description Text (11):

The TXRF analysis indicates metal levels at or below detection limits, except for K on the frontside. The K might be deeply embedded in the TEOS surface and thus hard to remove. The low level of metal contamination indicates that there is no metal cross-contamination between copper and TEOS wafers via the brush. In addition, there is no contamination to the wafer backside during the clean.

Detailed Description Paragraph Table (2):

TABLE 2

Data from TXRF Analysis of Wafer Frontside and Backside Following Slurry Dip and Subsequent "Post-CMP" Clean (Units: 10.sup.10 atoms/cm.sup.2) Wafer # K  
Ca Ti Cr Mn Fe Ni Cu Zn

	1
frontside	34 +/- 4 <4 <2 <1 <1 1.7 +/- 0.5 <0.8 <0.8 1.0 +/- 0.5 3
backside	<4 <3 <1 <0.7 <0.6 0.9 +/- 0.3 0.6 +/- 0.2 <0.5 1.5 +/- 0.3 20
frontside	9 +/- 3 <4 <2 <1 <1 2.4 +/- 0.5 1.0 +/- 0.4 <0.8 1.7 +/- 0.5 22
backside	<4 <3 <1 <1 <0.6 <0.5 <0.5 <0.5 0.7 +/- 0.3 Det. 4 3 1 0.7 0.6 0.5 0.5 0.5 0.7
Limits	

CLAIMS:

1. An aqueous composition comprising about 0.5% to about 5% by weight of fluoride containing material, about 0.05% to about 1% by weight of at least one dicarboxylic acid, salt thereof or mixture thereof;

about 0.5 to about 5% by weight of at least one hydroxy carboxylic acid, salt thereof or mixture thereof; and the remainder being substantially water, and

having a pH of about 3.0 to about 5.7.

2. The composition of claim 1 wherein the fluoride containing is selected from the group consisting of ammonium fluoride, hydrofluoric acid, antimony (III/VI) fluoride, barium fluoride, tin (II) fluoride, aluminum (III) fluoride, fluoroborates, tetramethylammonium fluoride, and fluoride salts of aliphatic primary, secondary and tertiary amine having the formula:

R.sub.1 N(R.sub.3)R.sub.2

wherein R.sub.1, R.sub.2 and R.sub.3 each individually represents H or an alkyl group having 12 carbon atoms or less.

3. The composition of claim 1 wherein the fluoride containing compound is

selected from the group consisting of ammonium fluoride or hydrofluoric acid.

5. The composition of claim 1 wherein the dicarboxylic acid or salt thereof has two to six carbon atoms.

6. The composition of claim 1 wherein the dicarboxylic acid is selected from the group consisting of oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, maleic acid and fumaric acid.

7. The composition of claim 1 wherein the dicarboxylic acid is malonic acid.

8. The composition of claim 1 wherein the hydroxy carboxylic acid is selected from the group consisting of malic acid, tartaric acid and citric acid.

9. The composition of claim 1 which comprises citric acid or ammonium citrate.

10. The composition of claim 1 which comprises citric acid.

12. The composition of claim 1 comprising ammonium fluoride, malonic acid and citric acid.

13. The composition of claim 1 having a pH of about 3.5 to about 5.4.

15. The composition of claim 1 wherein the amount of dicarboxylic acid is about 0.05 to about 0.2% by weight.

16. The composition of claim 1 wherein the amount of hydroxy carboxylic acid is about 0.5 to about 2% by weight.

19. A process for removing particulate contaminants from a copper surface after CMP planarization which comprises contacting a copper surface that has been planarized by CMP with an aqueous composition comprising a fluoride containing material;

at least one dicarboxylic acid, salt thereof or mixtures thereof; and

at least one hydroxycarboxylic acid, salt thereof or mixtures thereof, and having a pH of about 3.0 to about 5.7.

20. A process for fabricating semiconductor integrated circuits comprising:

forming circuits on the surface of a semiconductor wafer by photolithographic process wherein the circuits comprise copper or copper alloy;

planarizing the surface by chemical mechanical polishing;

and removing particulate contaminants from the surface by contacting with a aqueous composition comprising fluoride containing material;

at least one dicarboxylic acid, salt thereof or mixture thereof; and at least one hydroxy carboxylic acid, salt thereof or mixtures thereof and having a pH of about 3.0 to about 5.7.



23. An aqueous composition comprising about 1 to about 20% by weight of the fluoride containing material;

about 1 to about 10% by weight of a dicarboxylic acid, salt thereof, or mixtures thereof;

about 1 to about 30% by weight of a hydroxy carboxylic acid;

salt thereof or mixtures thereof, and 30 to about 50% by weight or water.

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Apr 17, 2003

DERWENT-ACC-NO: 1993-094034

DERWENT-WEEK: 200329

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TITLE: Forming oxide film - using vacuum equipment comprising a series of vessels sepd. by doors through which objects are passed and at least one of which has UV irradiation means

INVENTOR: AOYAMA, S; IMAOKA, T ; KONISHI, N ; MORITA, M ; NAKAMURA, M ; OHMI, T ; SHIBATA, T ; SHIMADA, H ; WAKAMATSU, H ; WATANABE, J ; YAMASHITA, T

## PATENT-ASSIGNEE:

ASSIGNEE	CODE
OHMI T	OHMI I
OOMI T	OOMI I
OMI T	OMI T I
DAIKEN T	DAIKI
AOYAMA S	AOYAI
IMAOKA T	IMAOI
KONISHI N	KONII
MORITA M	MORII
NAKAMURA M	NAKAI
SHIBATA T	SHIBI
SHIMADA H	SHIMI
WAKAMATSU H	WAKAI
WATANABE J	WATAI
YAMASHITA T	YAMAI
TAKASAGO NETSUGAKU KOGYO KK	TAKAN

PRIORITY-DATA: 1991JP-0238646 (August 26, 1991), 1991JP-0230939 (August 19, 1991), 1991JP-0232271 (August 20, 1991), 1991JP-0232272 (August 20, 1991), 1991JP-0232273 (August 20, 1991), 1991JP-0232274 (August 20, 1991), 1991JP-0232275 (August 20, 1991), 1991JP-0232276 (August 20, 1991), 1991JP-0232277 (August 20, 1991), 1991JP-0232278 (August 20, 1991), 1991JP-0232279 (August 20, 1991), 1991JP-0232280 (August 20, 1991)

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## PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
<input type="checkbox"/> <u>US 20030073278 A1</u>	April 17, 2003		000	H01L021/8238
<input type="checkbox"/> <u>WO 9304210 A1</u>	March 4, 1993	J	151	C23C008/10
<input type="checkbox"/> <u>JP 05045160 A</u>	February 23, 1993		000	G01B021/30
<input type="checkbox"/> <u>JP 05045311 A</u>	February 23, 1993		006	G01N023/227
<input type="checkbox"/> <u>JP 05047650 A</u>	February 26, 1993		000	H01L021/027
<input type="checkbox"/> <u>JP 05047713 A</u>	February 26, 1993		007	H01L021/302
<input type="checkbox"/> <u>JP 05047734 A</u>	February 26, 1993		000	H01L021/304
<input type="checkbox"/> <u>JP 05047735 A</u>	February 26, 1993		000	H01L021/304
<input type="checkbox"/> <u>JP 05047736 A</u>	February 26, 1993		000	H01L021/304
<input type="checkbox"/> <u>JP 05047746 A</u>	February 26, 1993		006	H01L021/31
<input type="checkbox"/> <u>JP 05047870 A</u>	February 26, 1993		000	H01L021/66
<input type="checkbox"/> <u>JP 05047910 A</u>	February 26, 1993		000	H01L021/68
<input type="checkbox"/> <u>JP 05051749 A</u>	March 2, 1993		004	C23C016/44
<input type="checkbox"/> <u>JP 05055197 A</u>	March 5, 1993		000	H01L021/316
<input type="checkbox"/> <u>EP 661385 A1</u>	July 5, 1995	E	108	C23C008/10
<input type="checkbox"/> <u>US 6146135 A</u>	November 14, 2000		000	F26B021/00
<input type="checkbox"/> <u>JP 3135626 B2</u>	February 19, 2001		006	G01N023/227

DESIGNATED-STATES: US AT BE CH DE DK ES FR GB GR IE IT LU MC NL SE BE DE FR  
GB IT NL

CITED-DOCUMENTS: 01Jnl.Ref; 1.Jnl.Ref ; DE 2657439 ; EP 260150 ; JP 01150328 ;  
JP 01195630 ; JP 03122514 ; JP 03125428 ; JP 03133044 ; JP 38019828 ; JP  
52077792 ; JP 58158930 ; JP 59110784 ; JP 60003121 ; JP 61141144 ; JP  
61160943 ; JP 61216318 ; JP 63072877 ; JP 87022527 ; JP 89049004 ; US  
4097738 ; US 4771730

## APPLICATION-DATA:

PUB-NO	APPL-DATE	APPL-NO	DESCRIPTOR
US20030073278A1	March 23, 1994	1994US-0196235	Cont of
US20030073278A1	April 11, 2002	2002US-0120628	
WO 9304210A1	August 19, 1992	1992WO-JP01048	
JP 05045160A	August 20, 1991	1991JP-0232278	
JP 05045311A	August 20, 1991	1991JP-0232277	
JP 05047650A	August 20, 1991	1991JP-0232271	
JP 05047713A	August 20, 1991	1991JP-0232276	
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JP 05047910A	August 19, 1991	1991JP-0230939	
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EP 661385A1	August 19, 1992	1992EP-0917995	
EP 661385A1	August 19, 1992	1992WO-JP01048	
EP 661385A1		WO 9304210	Based on
US 6146135A	March 23, 1994	1994US-0196235	Div ex
US 6146135A	July 9, 1996	1996US-0680519	
JP 3135626B2	August 20, 1991	1991JP-0232277	
JP 3135626B2		JP 5045311	Previous Publ.

6146135 A , JP 3135626 B2 INT-CL (IPC): B05C 11/08; C23C 8/10; C23C 14/35; C23C 16/44; C23C 16/48; C30B 21/324; C30B 33/02; F26B 3/00; F26B 19/00 ; F26B 21/00; G01B 21/30; G01N 23/227; G03F 7/16; G21K 1/14; G21K 5/00; H01J 37/28; H01L 21/027; H01L 21/203; H01L 21/263; H01L 21/265; H01L 21/285; H01L 21/302; H01L 21/304; H01L 21/31; H01L 21/316; H01L 21/66; H01L 21/68; H01L 21/8238; H05H 1/46

ABSTRACTED-PUB-NO: US 6146135A  
BASIC-ABSTRACT:

The vacuum equipment comprises a series of vacuum vessels sepd. by doors. The pressures in the vessels are reducible respectively. The vessels are so configured that objects to be processed are movable among them, and there is provided light projection means for projecting ultraviolet rays on gases introduced to at least one of the vessels.

ADVANTAGE - Equipment is capable of preventing particles from sticking to objects to be processed in vacuum vessels.  
ABSTRACTED-PUB-NO:

WO 9304210A  
EQUIVALENT-ABSTRACTS:

The vacuum equipment comprises a series of vacuum vessels sepd. by doors. The pressures in the vessels are reducible respectively. The vessels are so configured that objects to be processed are movable among them, and there is provided light projection means for projecting ultraviolet rays on gases introduced to at least one of the vessels.

ADVANTAGE - Equipment is capable of preventing particles from sticking to objects to be processed in vacuum vessels.

CHOSEN-DRAWING: Dwg.2/12

TITLE-TERMS: FORMING OXIDE FILM VACUUM EQUIPMENT COMPRISE SERIES VESSEL  
SEPARATE DOOR THROUGH OBJECT PASS ONE ULTRAVIOLET IRRADIATE

DERWENT-CLASS: L03 M13 Q76 U11

CPI-CODES: L04-C12A; L04-D01; M13-D03B; M13-E07; M13-H;

EPI-CODES: U11-C09; U11-F02A1;

SECONDARY-ACC-NO:

CPI Secondary Accession Numbers: C1993-041651

Non-CPI Secondary Accession Numbers: N1993-071907

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## Inventor Name Search Result

Your Search was:

Last Name = SHIH

First Name = TSU

Application#	Patent#	Status	Date Filed	Title	Inventor Name 51
<u>10665309</u>	Not Issued	020	09/22/2003	TUNGSTEN-COPPER INTERCONNECT AND METHOD FOR FABRICATING THE SAME	SHIH, TSU
<u>10453050</u>	Not Issued	020	06/03/2003	USE OF LOW-HIGH SLURRY FLOW TO ELIMINATE COPPER LINE DAMAGES	SHIH, TSU
<u>10422443</u>	Not Issued	030	04/24/2003	METHOD FOR COPPER SURFACE SMOOTHING	SHIH, TSU
<u>10374474</u>	Not Issued	030	02/24/2003	METHOD AND APPARATUS OF SIGNAL COMPRESSION USING ADAPTIVE PULSE CODE MODULATION WITH FRAME WIDTH ADJUSTMENT MEANS	SHIH, TSUNG- HAU
<u>10354710</u>	Not Issued	041	01/29/2003	METHOD FOR FORMING PATTERNED FEATURES AT A SEMICONDUCTOR WAFER PERIPHERY TO PREVENT METAL PEELING	SHIH, TSU
<u>10345762</u>	Not Issued	030	01/15/2003	METHOD TO REDUCE DISHING, EROSION AND LOW-K DIELECTRIC PEELING FOR COPPER IN	SHIH, TSU

				LOW-K DIELECTRIC CMP PROCESS	
<u>10283265</u>	Not Issued	051	10/30/2002	TRASH BIN EQUIPPED WITH AN AUTOMATIC LIFTING LID	SHIH, TSUNG-HWAN
<u>10266960</u>	Not Issued	041	10/08/2002	MULTIPLE LAYER COPPER DEPOSITION TO IMPROVE CMP PERFORMANCE	SHIH, TSU
<u>10188653</u>	Not Issued	092	07/02/2002	METHOD FOR DEMASCENE REWORKING	SHIH, TSU
<u>10188442</u>	6599838	150	07/02/2002	METHOD FOR FORMING METAL FILLED SEMICONDUCTOR FEATURES TO IMPROVE A SUBSEQUENT METAL CMP PROCESS	SHIH, TSU
<u>10154463</u>	6589852	150	05/23/2002	METHOD OF REPLICATING ALIGNMENT MARKS FOR SEMICONDUCTOR WAFER PHOTOLITHOGRAPHY	SHIH, TSU
<u>10150300</u>	Not Issued	071	05/17/2002	SACRIFICIAL FEATURE FOR CORROSION PREVENTION DURING CMP	SHIH, TSU
<u>10141221</u>	6638868	150	05/07/2002	METHOD FOR PREVENTING OR REDUCING ANODIC CU CORROSION DURING CMP	SHIH, TSU
<u>10140728</u>	Not Issued	041	05/07/2002	METHOD FOR ACHIEVING UNIFORM CU CMP POLISHING	SHIH, TSU
<u>10132442</u>	Not Issued	094	04/25/2002	METHOD FOR PREVENTING LOCALIZED CU CORROSION DURING CMP	SHIH, TSU
<u>10132441</u>	6638328	150	04/25/2002	BIMODAL SLURRY SYSTEM	SHIH, TSU
<u>10082009</u>	Not Issued	030	02/20/2002	METHOD FOR PREVENTING CHEMICAL ATTACK ON A COPPER	SHIH, TSU

				CONTAINING SEMICONDUCTOR WAFER	
<u>10077071</u>	<u>6515366</u>	150	02/14/2002	REDUCTION OF METAL CORROSION IN SEMICONDUCTOR DEVICES	SHIH, TSU
<u>10072244</u>	<u>6686284</u>	150	02/06/2002	CHEMICAL MECHANICAL POLISHER EQUIPPED WITH CHILLED RETAINING RING AND METHOD OF USING	SHIH, TSU
<u>10043780</u>	<u>6620034</u>	150	01/14/2002	NOVEL WAY TO REMOVE CU LINE DAMAGE AFTER CU CMP	SHIH, TSU
<u>09989838</u>	Not Issued	093	11/20/2001	ELIMINATE BROKEN LINE DAMAGE OF COPPER AFTER CMP	SHIH, TSU
<u>09947788</u>	<u>6602780</u>	150	09/06/2001	METHOD FOR PROTECTING SIDEWALLS OF ETCHED OPENINGS TO PREVENT VIA POISONING	SHIH, TSU
<u>09945435</u>	<u>6544891</u>	150	09/04/2001	METHOD TO ELIMINATE POST-CMP COPPER FLAKE DEFECT	SHIH, TSU
<u>09940250</u>	<u>6510885</u>	150	08/27/2001	VERTICAL BLINDS CURTAIN ATTACHMENT	SHIH, TSUIYING TSAI
<u>09919849</u>	<u>6711107</u>	150	08/02/2001	SYSTEM FOR CONSTANT ANGULAR VELOCITY DISK RECORDING AND METHOD FOR LASER POWER CONTROL THEREOF	SHIH, TSUNG YUEH
<u>09915035</u>	<u>6501186</u>	150	07/25/2001	BOND PAD HAVING VARIABLE DENSITY VIA SUPPORT AND METHOD FOR FABRICATION	SHIH, TSU
<u>09902896</u>	<u>6383930</u>	150	07/12/2001	METHOD TO ELIMINATE COPPER CMP RESIDUE OF AN ALIGNMENT MARK FOR DAMASCENE PROCESSES	SHIH, TSU



<u>09888789</u>	<u>6635211</u>	150	06/25/2001	REINFORCED POLISHING PAD FOR LINEAR CHEMICAL MECHANICAL POLISHING AND METHOD FOR FORMING	SHIH, TSU
<u>09867563</u>	Not Issued	041	05/31/2001	METHOD TO ELIMINATE VIA POISON EFFECT	SHIH, TSU
<u>09839700</u>	<u>6518166</u>	150	04/23/2001	LIQUID PHASE DEPOSITION OF A SILICON OXIDE LAYER FOR USE AS A LINER ON THE SURFACE OF A DUAL DAMASCENE OPENING IN A LOW DIELECTRIC CONSTANT LAYER	SHIH, TSU
<u>09818714</u>	<u>6458689</u>	150	03/28/2001	USE OF PE-SION OR PE-OXIDE FOR CONTACT OR VIA PHOTO AND FOR DEFECT REDUCTION WITH OXIDE AND W CHEMICAL-MECHANICAL POLISH	SHIH, TSU
<u>09815427</u>	<u>6398627</u>	150	03/22/2001	SLURRY DISPENSER HAVING MULTIPLE ADJUSTABLE NOZZLES	SHIH, TSU
<u>09713827</u>	<u>6409587</u>	150	11/15/2000	DUAL-HARDNESS POLISHING PAD FOR LINEAR POLISHER AND METHOD FOR FABRICATION	SHIH, TSU
<u>09687162</u>	<u>6383935</u>	150	10/16/2000	METHOD OF REDUCING DISHING AND EROSION USING A SACRIFICIAL LAYER	SHIH, TSU
<u>09683847</u>	Not Issued	030	02/21/2002	ENCODING METHOD FOR AN OPTICAL RECORDER	SHIH, TSUNG-YUEH
<u>09664414</u>	<u>6429118</u>	150	09/18/2000	ELIMINATION OF ELECTROCHEMICAL DEPOSITION COPPER LINE DAMAGE FOR DAMASCENE PROCESSING	SHIH, TSU

<u>09635013</u>	<u>6634930</u>	150	08/09/2000	METHOD AND APPARATUS FOR PREVENTING METAL CORROSION DURING CHEMICAL MECHANICAL POLISHING	SHIH, TSU
<u>09578409</u>	<u>6350680</u>	150	05/26/2000	NEW PAD ALIGNMENT FOR ALCU PAD FOR COPPER PROCESS	SHIH, TSU
<u>09570019</u>	<u>6361704</u>	150	05/12/2000	SELF STOP ALUMINUM PAD FOR COPPER PROCESS	SHIH, TSU
<u>09547256</u>	<u>6443810</u>	150	04/11/2000	POLISHING PLATEN EQUIPPED WITH GUARD RING FOR CHEMICAL MECHANICAL POLISHING	SHIH, TSU
<u>09543718</u>	Not Issued	164	04/05/2000	ENHANCED DURABILITY BOND PAD STRUCTURE AND METHOD FOR FABRICATION THEREOF	SHIH, TSU
<u>09541486</u>	Not Issued	060	04/03/2000	METHOD AND COMPOSITION FOR POST CHEMICAL MECHANICAL POLISH (CMP) PLANARIZING CLEANING OF A CHEMICAL MECHANICAL POLISH (CMP) PLANARIZED COPPER CONTAINING CONDUCTOR LAYER	SHIH, TSU
<u>09490138</u>	<u>6372632</u>	150	01/24/2000	METHOD TO ELIMINATE DISHING OF COPPER INTERCONNECTS BY THE USE OF A SACRIFICIAL OXIDE LAYER	SHIH, TSU
<u>09211288</u>	Not Issued	161	12/16/1998	PAGING RECEIVER WITH RETURN CALL DIALING CAPABILITY	SHIH, TSUN-TE
<u>08950234</u>	Not Issued	161	10/14/1997	METHOD FOR CMP CLEANING IMPROVEMENT	SHIH, TSU
<u>08730382</u>	<u>5858854</u>	150	10/16/1996	NEW METOHOD FOR	SHIH, TSU

				FORMING HIGH CONTRAST ALIGNMENT MARKS	
<a href="#">08684806</a>	<a href="#">5773196</a>	150	07/22/1996	PREVENTION OF ANTI- REFLECTION COATING DAMAGE	SHIH , TSU
<a href="#">08657069</a>	<a href="#">5827782</a>	150	06/03/1996	MULTIPLE ETCH METHOD FOR OPTIMIZING INTER- METAL DIELECTRIC (IMD) SPACER LAYER PROFILE	SHIH , TSU
<a href="#">08638674</a>	<a href="#">5654234</a>	150	04/29/1996	METHOD FOR FORMING A VOID-FREE TUNGSTEN- PLUG CONTACT IN THE PRESENCE OF A CONTACT OPENING OVERHANG	SHIH , TSU
<a href="#">07690220</a>	Not Issued	161	04/24/1991	GOLF CART WHEEL AXLE BEARING UNIT	SHIH , TSUNG- MING
<a href="#">06258114</a>	<a href="#">4543432</a>	150	04/27/1981	SEPARATION OF ISOPROPYL ALCOHOL FROM TERTIARY BUTYL ALCOHOL BY SELECTIVE ADSORPTION	SHIH , TSUNG- SHEN T.

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## Inventor Name Search Result

Your Search was:

Last Name = CHEN

First Name = YING-TSUNG

Application#	Patent#	Status	Date Filed	Title	Inventor Name
<a href="#">10337684</a>	Not Issued	041	01/07/2003	METHOD OF FORMING COPPER INTERCONNECTS	CHEN, YING-TSUNG
<a href="#">10082009</a>	Not Issued	030	02/20/2002	METHOD FOR PREVENTING CHEMICAL ATTACK ON A COPPER CONTAINING SEMICONDUCTOR WAFER	CHEN, YING-TSUNG
<a href="#">09886925</a>	<a href="#">6425335</a>	150	06/20/2001	MINIATURE GARBAGE INCINERATOR	CHEN, YING-TSUNG
<a href="#">09685748</a>	Not Issued	161	10/11/2000	PROCESS AND APPARATUS FOR CLEANING SEMICONDUCTOR WAFER OR THIN FILM	CHEN, YING-TSUNG
<a href="#">09076116</a>	<a href="#">6037260</a>	150	05/12/1998	POLISHING COMPOSITION	CHEN, YING-TSUNG

Inventor Search Completed: No Records to Display.

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